REMARKS

Claims 1-10, 12-19 and 21 are in this application. Claims 11 and 20 have been cancelled and claims 12-19 are withdrawn.

According to the Examiner claims 1-5 and 7-10 are rejected as being obvious over Shimizu, et al. (JP 04-350107 with machine English translation, thereafter JP'107) in view of Akiyoshi (JP 02-166202, thereafter JP'202). This is respectfully traversed.

It is clear upon that the method and apparatus claimed in the present invention are not obvious in view of the disclosure of the cited prior art. Claim 1 defines a process for the production of metallic nanoparticles by controlled electro-explosion of a metallic wire. As set out in step (ii) of claim 1, the first and second electrodes are exploded instantaneously by sending shock waves through the bulk of the material, thereby melting the electrodes and dispersing them to form nanoparticles. Furthermore, JP '107 does not disclose a process for the production of metallic nanoparticles. According to the abstract from the Euopean Patent Office, the reference discloses a method for producing metal nitride powder. The particles are spherical particles and are not described as nanoparticles. In addition, the process used for nitriding which according to WIKIPEDIA is a process which introduces nitrogen into the surface of a material. This is completely different from preparing metallic nanoparticles and collecting the nanoparticles.

The Examiner refers to paragraph [0019] of the '107 reference. Although this paragraph refers to generation of granular materials which adhered to an inner wall or the bottom in ethanol were collected, there is no disclosure or suggestion that this granular material are nanoparticles.

The particles produced in '202 are not nanoparticles. They are described as small diameter metal particles having about 0.1 to 0.01 μm diameter. In addition, this reference teaches use of arc discharge which is not used in the claimed process. This reference also teaches rapid cooling and solidifying.

Given the differences between the two references there is no combination of these references that make the claimed invention obvious. According to the U.S. Supreme Court in KSR v Teleflex and as included in the Examination Guidelines for Determining Obviousness Under 35 USC 103 "[R]ejections on obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." Since this has not been shown, it is respectfully requested that the rejection be withdrawn.

The Examiner also alleges that claims 5, 6 and 21 are rejected as being obvious in view of the references cited above in combination with US Patent 6,884,405.

This is respectfully traversed.

For the reasons explained above, the claims are distinguished from the two Japanese references. Claims 5, 6 and 21 are also not obvious over these references in combination with the '405 patent.

The process described in the '405 patent differs from the claimed process. One difference is that the '405 process teaches production of an arc. The claims of the subject application refer to spark explosion and melting the electrodes.

Claim 6 defines that the current required for the electro-explosion process in the present invention is on the order of one million amperes per square meter A/m^2 as against 40,000 A/m^2 mentioned in U.S. Patent 6,884,405.

The production method claimed in this application involves inventive merit and a notable improvement in metal powder production based on a completely different approach from those adopted by the cited methods.

Accordingly, it is respectfully requested that the rejection be withdrawn.

Fees for extension of time may be charged to deposit account 12-0425.

Applicants submit that the present application is in condition for allowance and favorable consideration is respectfully requested.

Respectfully submitted,

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Nitriding

From Wikipedia, the free encyclopedia

Nitriding, also known as **nitridization**, is a process which introduces nitrogen into the surface of a material. It is used in metallurgy, for example, for case hardening treatment of predominantly steel but also for titanium, aluminium and molybdenum.

Nitriding is widely used in automotive, mechanical and aeronautical engineering. Typical components receiving this metallurgical process are gears, crankshafts, camshafts, cam followers, valve parts, extruder screws, die-casting tools, forging dies, extrusion dies, injectors and plastic-mould tools.

Contents

History

Systematic investigation into the effect of nitrogen on the surface properties of steel only started in the 1920s. Investigation into gas nitriding began independently in both Germany and America. The process was greeted with enthusiasm in Germany and several steel grades were developed with nitriding especially in mind, these are the so called nitriding steels. The reception in America, on the other hand, was less impressive. With so little demand the process was more or less forgotten in the US. It was only after World War II that the process was reintroduced from Europe. Today, nitriding is one of the most significant surface engineering treatments for steels. A great deal of research has taken place in the last few details to understand the thermodynamics and kinetics of the reactions taking place.

Process

All nitriding processes enrich the surface of a material with nitrogen. Processes are named by the medium used to donate nitrogen. The three main methods used are:

- Gas nitriding
- Liquid or salt bath nitriding
- Ion or plasma nitriding

Gas nitriding

In gas nitriding the donor is a nitrogen rich gas usually ammonia (NH_3). When ammonia comes into contact with the heated work piece it disassociates into nitrogen and hydrogen. The nitrogen then

diffuses from the surface into the core of the material. This is the oldest of the current nitriding processes though only in the last few decades has there been a concentrated effort to investigate the thermodynamics and kinetics involved. Recent developments have lead to a process that can be accurately controlled. The thickness and phase constitution of the resulting nitriding layers can be selected and the process optimized for the particular properties required. The advantages of gas nitriding over the other variants are:

- All round nitriding effect (can be a disadvantage in some cases, compare with plasma nitriding)
- Large batch sizes possible - the limiting factor being furnace size and gas flow
- With modern computer control of the atmosphere the nitriding results can be tightly controlled
- Relatively cheap equipment cost - especially compared with plasma

The disadvantages of gas nitriding are:

- Reaction kinetics heavily influenced by surface condition - an oily surface or one contaminated with cutting fluids for example will deliver poor results
- Surface activation is sometimes required to successfully treat steels with a high chromium content - compare sputtering during plasma nitriding
- Ammonia as nitriding medium - though not especially toxic it does cause panic when inhaled. Also care must be taken when heating in the presence of oxygen to reduce the risk of explosion

Salt bath nitriding

In salt bath nitriding the nitrogen donating medium is a nitrogen containing salt such as cyanide salt. The salts used also donate carbon to the workpiece surface making salt bath a nitrocarburising process. The temperature used is typical of all nitrocarburising processes; 550-590°C The advantages of salt nitriding are:

- Quick processing time - usually in the order of 4 hours or so to achieve
- Simple operation - heat the salt and workpieces to temperature and submerge until the duration has expired

The disadvantages are:

- The salts used are highly toxic - Disposal of salts are controlled by stringent environmental laws in western countries and has increased the costs involved in using salt baths. This is one of the most significant reasons the process has fallen out of favor in the last decade or so.
- Only one process possible with a particular salt type - since the nitrogen potential is set by the salt, only one type of process is possible.

Plasma nitriding

Materials for nitriding

Examples of easily nitridable steels include the SAE 4100, 4300, 5100, 6100, 8600, 8700, 9300 and 9800 series, stainless steels, some tool steels and certain cast irons. Ideally, steels for nitriding should be in the hardened and tempered condition, requiring nitriding take place at a lower temperature than the last tempering temperature. A fine-turned or ground surface finish is best.

Equipment

The equipment can be expensive, but tooling costs are generally low, and many parts can be treated simultaneously, keeping labor cost low. Since pack nitriding may require the use of *cyanide* salts, this process requires stringent safety precautions and environmental regulation. Disposal of spent baths must follow proper procedures.

See also

- Carburization
- Carbonitriding
- Case hardening
- Surface engineering
- Surface finishing
- HEF Groupe, international nitriding company

References

- Ruth Chatterjee-Fischer - Wärmebehandlung von Eisenwerkstoffen: Nitrieren und Nitrocarburieren [Heat treatment of ferrous materials: nitriding and nitrocarburising] 1995 2nd Edition Expert Verlag ISBN 3-8159-1092

External links

- Key to Steel - Nitriding

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